SCIENCE

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ON THE FUNDAMENTAL HYPOTHESES OF ABSTRACT DYNAMICS.[1]

BY PROFESSOR J. G. MACGREGOR, D.SC.

THE formally recognized axioms of abstract dynamics employed by most writers are the three Laws of Motion enunciated by Newton in the "Principia," not always in the form given them by Newton, but in some form or other. It is obviously important that such axioms should be precise in their enunciation, independent of one another, sufficient for the deduction of all propositions applicable to natural forces generally, and as few as possible.

These axioms are sometimes regarded as constituting a definition[2] of force. As defining force, however, they are not consistent with one another; for momentum being a relative conception, i.e., having magnitude and direction which vary with the point by reference to which velocity is specified, force, if defined by the first and second laws, must also be a relative conception. And it follows that the third law cannot in general hold; for it is easy to show that if it hold for one point of reference, it cannot hold for another having an acceleration relative to the first.

The axioms are thus statements about the action of force, force being assumed to be already a familiar conception. As applicable to the translation of bodies, they may be regarded either as hypotheses verified by the deductions made from them, or as generalizations established by direct though rough experiments. When, however, we come to study the effect of force in changing the rotation of bodies or their state of strain, we assume the laws of motion to hold for the small parts (particles or elements) of which we imagine the bodies to consist. And therefore, as forming the basis of dynamics as a whole, they must be regarded as hypotheses. In either case it is necessary to note that both the popular and the scientific conceptions of force ascribe to it a magnitude and direction quite independent of the point of reference which may be used in specifying the motion of the body on which it acts.

1. The Precision of the Laws of Motion.

Owing to this non-relative character of force, it is obvious that the first and second laws of motion can hold only provided the motion of bodies be specified relatively to certain points. In omitting the mention of these points, Newton's laws are somewhat lacking in precision; and it is important to determine what the points are.

As, according to the first law, two particles which are both free from the action of force must have uniform velocities, relatively to the unspecified point of reference, each must have a uniform velocity relatively to the other. Hence the first law, as pointed out by Tait,[3] holds relatively to any particle on which no forces act.

As, according to the second law, the acceleration of either a particle of finite mass acted upon by no force, or a particle of infinite mass acted upon by no infinite force, must be zero relatively to the unspecified point of reference, this law must hold relatively to all such particles.

But such particles are fictitious. To bring the second law within the region of practical application, we must find accessible points by reference to which it holds. This may readily be done; for it is easy to prove it to hold for a particle acted upon by given forces, relatively to any other particle, with respect to which, but for the action of these forces, the former would have no acceleration. Thus, as is usually assumed, the acceleration, relative to a point of the earth's surface, of a body situated at that point and at rest or in uniform motion relatively to it, except in so far as its motion may be modified by given forces, may be determined by the application of the second law.

It is interesting to note that this was the point of reference employed by Newton in the experiments made by him to verify the third law. In these well-known experiments[4] on the impact of spheres, the spheres were suspended by strings, and impact was made to occur when the spheres occupied their lowest positions. Their velocities before and after impact were taken to be proportional to the chords of the arcs (corrected for resistance of air), through which they had fallen, or were found to rise respectively. Hence the acceleration of a freely falling body was assumed to be vertical; and the point of reference was consequently the point of the earth's surface at which the experiments were made. Also at the instant of impact, the spheres were passing through their positions of zero acceleration relatively to this point. Hence the equal and opposite changes of momentum observed were specified by reference to a point with respect to which, apart from the action of the stress due to impact, the impinging spheres had no acceleration.

As the third law asserts merely the equality and opposition of two forces, it must hold for all points of reference; or rather it is independent of points of reference.

It follows that besides the points mentioned above, with respect to which the second law holds, there is, in the case of a system of particles, free from the action of external force, another, viz., the centre of mass of the system. For this point may be shown by the aid of the third law to have no acceleration relatively to any point, by reference to which the second law holds.

It may easily be proved that the stress between two particles is proportional to the product, by the sum of their masses into their relative acceleration; and that consequently, if one of the particles be of infinite mass, the stress is proportional to the mass of the other multiplied by the relative acceleration. Hence if, in applying the second law of motion, a particle of infinite mass be chosen as point of reference, all the forces acting on a system of particles, both external and internal, may be regarded as exerted upon them by the particle of infinite mass.

[1] Abstract of the presidential address to the Mathematical and Physical Section of the Royal Society of Canada, at the meeting held May, 1892.

[2] Maxwell's Matter and Motion, Art. XL.

[3] Properties of Matter (1885), p. 92.

[4] Principia: Scholium to Axiomata.

2. Independence of the Laws of Motion.

Maxwell[1] maintains that "the denial of Newton's first law is in contradiction to the only system of consistent doctrine about space and time which the human mind has been able to form." If this be so, it must be possible to deduce the law from the doctrine of space and time, and it cannot be held to be hypothetical in character. Maxwell's argument is as follows: "If the velocity [of a body freed from the action of force] does not remain constant, let us suppose it to vary. The change of velocity must have a definite direction and magnitude. By the maxim that the same causes will always produce the same effects, this variation must be the same, whatever be the time or place of the experiment. The direction of the change of motion must therefore be determined either by the direction of the motion itself or by some direction fixed in the body. Let us, in the first place, suppose the law to be that the velocity diminishes at a certain rate. . . . The velocity referred to in this hypothetical law can only be the velocity referred to a point absolutely at rest. For if it is a relative velocity, its direction as well as its magnitude depends on the velocity of the point of reference. . . . Hence the hypothetical law is without meaning unless we admit the possibility of defining absolute rest and absolute velocity."

This argument, which is endorsed by Tait,[2] may be used to prove Newton's law also to be without meaning. For this purpose all that is necessary is to substitute *displacement* for *velocity* or *motion*, wherever these words occur in the above quotation, and *changes* for *diminishes*. The argument is thus transformed into one equally good or bad, in favor of the cessation of motion on the cessation of the action of force, as against Newton's law.

The fallacy — for the argument would thus appear to be fallacious — seems to lie in the incomplete recognition of the relativity of the law of motion under consideration. Thus, when, in the second sentence of the above quotation, Maxwell says: "The change of velocity must have a definite magnitude and direction," he forgets that its magnitude and direction must vary with the point of reference. And the whole argument turns upon this asserted definiteness.

While the first law must be considered incapable of deduction, its right to formal enunciation among the fundamental hypotheses of dynamics has often been disputed on the ground of its being a particular case of the second law. This must be admitted; and its separate enunciation must therefore be pronounced illogical.

There is one objection, however, which may perhaps be urged against the omission of the first law, viz., that Maxwell[3] and other authorities hold that this law, "by stating under what circumstances the velocity of a moving body remains constant, supplies us with a method of defining equal intervals" of time. As no such statement is ever made about the second law, it would thus appear that the omission of the first would leave us without a basis for the measurement of time.

This objection, however, is easily met. For, first, the second law supplies us with more methods of defining equal intervals of time than the first law. In addition to the definition given by the latter, it tells us, for example, that those intervals are equal in which a body acted upon by a constant force undergoes equal changes of velocity.

Second, both laws assume that equal intervals of time have already been defined. So far as power of defining is concerned, therefore, they give us nothing that we did not possess before their enunciation. The only advance in time-measurement which we owe them is that they show us how to construct time-pieces which will mark off for us the intervals assumed to be equal in their enunciation.

Third, the intervals assumed equal in the enunciation of these laws are not known to be equal. What they assume is therefore nothing more than a conventional time-scale; and what they give us is nothing more than certain methods of securing accurate copies of this scale.

And, fourth, both of these laws may be enunciated so as to retain all their dynamical significance, and yet make no reference to the measurement of time, by adopting as the definition of velocity not distance traversed per unit of time, but the distance traversed while the earth (or, better, a certain ideal earth) rotates through a certain angle relatively to the fixed stars. Enunciated in this way these laws assume no definition of equal intervals of time, and can consequently supply us with no such definitions.

Newton's second law asserts that the acceleration produced in a body by a force is directly proportional to the force and has the same direction; and as the assertion is without restriction, the law implies that the effect of the force is the same, whatever the motion of the body may be and whatever other forces may be acting upon it. Many writers regard the latter implied part of the law as being the only hypothetical part. They therefore make it the second law of motion and attempt to deduce the former part from it, the argument being that since any number n of equal and codirectional forces will produce in a body an acceleration n times as great as that produced by one, the acceleration produced in a body must be proportional to the force producing it. It is here assumed, however, that n equal forces in the same direction are equivalent to a single force of n times the magnitude. Thus the explicitly asserted portion of Newton's second law cannot be deduced from the implied portion except by the aid of an additional hypothesis; and the law as a whole must therefore be regarded as hypothetical.

The third law is supposed to have been deduced from the first by Newton himself. Maxwell[4] appears to hold this view; Lodge[5] declares his adhesion to it; and Tait[6] says the third law "is very closely connected with the first." Newton's discussion[7] of the third law, in which he is supposed to make this deduction, consists of two parts. He first shows by the experiments referred to above, that the law applies to the case of the stresses between bodies pressing against one another; and he then extends it by the aid of the first law to gravitational stresses, and by the aid of further experiment to magnetic stresses as well. In this extension he does not say that he is building upon the results of his experiments on impact, but it seems obvious that he does so. Maxwell summarizes his argument admirably in the following words: "If the attraction of any part of the earth, say, a mountain, upon the remainder of the earth, were greater or less than that of the remainder of the earth upon the mountain, there would be a residual force acting upon the system of the earth and the mountain as a whole, which

[1] Matter and Motion, Art. XLI.

[2] Ency. Brit., 9th Ed., Art. Mechanics, § 298.

[3] Matter and Motion, Art. .XLIII

[4] Matter and Motion, Art. LVIII.

[5] Elementary Mechanics (1885), p. 56.

[6] Properties of Matter (1885), p. 103.

[7] Principia: Schollum to Axiomata.

would cause it to move off with an ever-increasing velocity through infinite space. This is contrary to the first law of motion, which asserts that a body does not change its state of motion unless acted upon by external force." That this argument is based upon the assumption of the equality of the action and reaction between bodies pressing against one another, seems to follow from the consideration that otherwise the "residual force," due to the possible inequality of the action and reaction of the gravitational stress between the mountain and the remainder of the earth, might be regarded as neutralized by an opposite inequality in the action and reaction of the stress at their surface of contact. Even, therefore, if Newton's extension of his experimental result to forces acting at a distance were regarded as valid, the third law could not be regarded as deduced from the first. It would only be shown to be but partially hypothetical. But since, in the present state of dynamics, the laws of motion must be regarded as applicable to particles, Newton's argument, though valid when they were considered applicable to extended bodies, can no longer be admitted; for the uniformity of the motion of a body free from the action of external force is itself a deduction, which can be made only by assuming the third law in its most general form.

3. Sufficiency of the Laws of Motion.

The best test of the sufficiency of the laws of motion is the question, Can they give by deduction the greatest of all physical laws, the conservation of energy? This law may be proved, by the aid of the second and third laws of motion, to hold in the case of any system of particles which is neither giving energy to, nor receiving energy from, external bodies, provided the stresses between the particles act in the lines joining them and are functions of their distances. It has also been proved by experiment to hold in a very large number of cases in which the laws of the forces acting are unknown, the energy disappearing in one form and the energy appearing simultaneously in another form being measured. The amount of such experimental evidence is so large that no doubt is now entertained that the law of the conservation of energy is applicable to all natural forces. Hence the fundamental hypotheses of dynamics should either include this law or give it by deduction.

Although many writers state that this law may be deduced from the laws of motion, Lodge[1] is the only one, so far as I am aware, who claims to make the deduction. This he does in a passage beginning as follows: "All this, indeed, in a much more complete and accurate form — more complete because it involves the *non destruction* of energy, as well as its non-creation — follows from Newton's third law of motion, provided we make the assumptions (justified by experiment)," etc. It is unnecessary to quote farther; for when assumptions justified by experiment are called in to the aid of the third law, additional fundamental hypotheses are thereby selected.

The second law of motion enables us to take the first step in the deduction of the conservation of energy. The proof is so well known that I may simply cite that given by Thomson and Tait,[2] resulting in the familiar equation: —

$$\Sigma (X \dot{x} + Y \dot{y} + Z \dot{z}) = \Sigma m (\ddot{x} \dot{x} + \ddot{y} \dot{y} + \ddot{z} \dot{z}),$$

in which the first member represents the rate at which work is being done by the forces acting on the particles of a system, and the second is equal to the rate at which the kinetic energy of the system is being increased. It is usually called the equation of *vis viva*, and, having been deduced from the second law of motion alone, is applicable to all forces, whether conservative or not.

Newton gave this result in the Scholium to the Laws of Motion in a statement which may be paraphrased thus: Work done on any system of bodies has its equivalent in work done against friction, molecular forces, or gravity, together with that done in overcoming the resistance to acceleration. Thompson and Tait point out expressly[3] that this statement of Newton's, which, owing to the form he gave it, is often referred to as his second interpretation of the third law of motion, is equivalent to the equation given above. Nevertheless, it has been interpreted as being little less than an enunciation of the law of the conservation of energy itself.[4] Thus Tait[5] says it "has been shown to require comparatively little addition to make it a complete enunciation of the conservation of energy;" and "What Newton really wanted was to know what becomes of work which is spent in friction." Besant[6] takes the same view.[7] These writers seem to claim that Newton's statement is equivalent to what Thomson and Tait call "the law of energy in abstract dynamics," viz., "The whole work done in any time on any limited material system by applied forces is equal to the whole effect in the forms of potential and kinetic energy produced in the system, together with the work lost in friction." Of this it may certainly be said that what it wants to make it a complete enunciation of the conservation of energy is a statement as to what becomes of the work spent in friction.

Compare this, however, with Newton's statement, as paraphrased above, and it is at once obvious that what the latter wants to make it a complete enunciation of the conservation of energy, is a statement as to what becomes not only of work spent in friction, but also of work done against molecular forces and gravity, and of work done in overcoming the resistance to acceleration. Newton may possibly have known all this, but he does not say so; and we must therefore hold his statement to be, as Thomson and Tait point out, merely a verbal expression of the equation given above. The question of the interpretation of Newton's statement is of more than mere historical interest; for if it would bear the interpretations which have been put upon it, the law of the conservation of energy would be capable of being deduced from the second law of motion alone.

To pass from the equation of *vis viva* to the law of the conservation of energy, we require to know that the work done during any change of configuration of a system of particles acted upon by natural forces depends only upon the changes in the positions of the particles, and not upon the paths by which or the velocities with which they have moved from the old positions to the new. Helmholtz[8] showed that this deduction may be "based on either of two maxims, either on the maxim that it is not possible by any

[1] Elementary Mechanics (1885), p. 82.

[2] Treatise on Nat. Phil. (1879), Vol. I., Part 1, p. 269.

[3] Treatise on Nat. Phil. (1879), Vol. I., Part 1, p. 270.

[4] This address was written before I had seen Professor W. W. Johnson's paper on "The Mechanical Axioms, or Laws of Motion" (Bull. N. Y. Math. Soc., Vol. I., No. 6, March, 1892).

[5] Properties of Matter (1885), p. 104, and Recent Advances in Physical Science (1876), p. 38.

[6] Dynamics (1885), p. 49.

[7] Garrett (Elementary Dynamics, 1886, p. 47) goes so far as to say that Newton's statement "is nothing more nor less than the enunciation of the great principle of the conservation of energy."

[8] On the Conservation of Force (1847): Taylor's Scientific Memoirs. Nat. Phil. (1853), p. 114.

combination whatever of natural bodies to derive an unlimited amount of mechanical force [energy], or on the assumption that all actions in nature can be ultimately referred to attractive or repulsive forces, the intensity of which depends solely upon the distances between the points by which the forces are exerted." He showed also that it was immaterial which of these maxims was assumed, as the other could be at once obtained from it. How by the aid of either of these hypotheses we pass from the equation given above to the law of the conservation of energy is of course well known. The point to which it seems necessary to draw attention is that some hypothesis is required, and that either of these is sufficient for the purpose.

As the second of Helmholtz's maxims is simply an extension of the third law of motion, and as Newton's three laws have obtained such wide usage, it would seem to be desirable to adopt the second maxim as a fourth law of motion. Were we to select the first maxim, it would be necessary to re-cast our fundamental hypotheses altogether.[1] Possibly it might be advantageous to take this course, to make, as Tait[2] suggests, the laws of the conservation and the transformation of energy our fundamental hypotheses, and to banish the conception of force to the limbo of once useful things. But if Newton's laws are to be retained, they should be supplemented by the second of Helmholtz's assumptions.

It is at once obvious that this fourth law will, like the third, be independent of points of reference; and it follows that the law of the conservation of energy will hold relatively to all points by reference to which the second law holds. This conclusion is inconsistent with Newcomb's assertion[3] that this law "assumes that we refer the motions of all the bodies whose energy is considered to some foreign body of infinite mass, from which emanate the forces which give motion to the system." According to the above, this law may of course be expressed relatively to a particle of infinite mass, and, if thus expressed, the forces which give motion to the system may be supposed to emanate from that particle. But it may also be expressed relatively either to a particle of finite mass free from the action of force, or to the centre of mass of the system itself whose energy is conserved.

4. Reduction of the Laws of Motion.

Finally, the four laws of motion may obviously be reduced to two. The first has already been seen to be a particular case of the second. The third is involved in the fourth; for when it is asserted that natural forces are attractions or repulsions, it is implied that their action and reaction are in opposite directions, and when it is asserted that they may be expressed as functions of the distances of the particles between which they act, it is implied that their action and reaction are equal. The four laws thus reduce to two, which may be enunciated somewhat as follows:—

The Law of Force. — Relatively to any particle free from the action of force, the acceleration produced in another particle by a force is proportional to the force and has the same direction.

The Law of Stress. — Natural forces may be considered to be attractions or repulsions whose magnitudes vary solely with the distances of the particles between which they act.

[1] Many writers illogically select the first maxim as a fourth law. See Professor Johnson's paper cited above; also my Kinematics and Dynamics, § 436.

[2] Ency. Brit., 9th Ed., Art. Mechanics, § 291.

[3] Phil. Mag., Ser. 5, Vol xxvii. (1889), p. 116.

THE GREAT LAKE BASINS.

BY P. J. FARNSWORTH.

THE problem of the origin of the Great Lakes has for a long time engaged the attention of the scientists, who have come to a variety of conclusions, none of them very satisfactory. Subsidence, ice action, glacial scooping, and President Chamberlin's theory that they were hollows made by accumulating ice bending down the earth's crust.

An article in *Science* of June 3 presents a more plausible theory, that they are vallies of erosion, made by some great river, giving as evidence the map of Dr. Spencer, pointing out the discoveries and probable deep pre-glacial channels leading into the St. Lawrence and the Atlantic. Professor Spencer, in his paper on High Continental Elevations, read at the Scientific Association at Toronto, 1889, sums up by saying, "The lake basins are merely closed-up portions of the ancient St. Lawrence valley and its tributaries." "The lake basins are all excavated out of Palæozoic rocks except a part of that of Lake Superior."

If we go back in geologic history to Azoic times we find that the first emergence of the continent was the V-shaped land around Hudson's Bay, an open sea below it. Next, an emergence of a point below the V and a line of height extending along the lower side of what we call the river and gulf of St. Lawrence. A sea or strait extended round the primitive land from the Atlantic to the Arctic Ocean on the north-west. After the elevation of the trough at the north-west, an inland sea was left covering Superior, Michigan, Huron, and Ontario, leading into the St. Lawrence Gulf. In time there was elevation and subsidence and flexion of strata, as pointed out by Professor Spencer, and the great basins were left as interior seas. There was a large water-shed to the north that compelled an overflow, that made its way in the deep channels that have been discovered, at some time out of Ontario, across New York, then, if there was continental elevation, making the deep channels down the valley of the St. Lawrence and far out into the Gulf. Lake Champlain was a pool in a fissure of the Azoac world, that was connected with the open channel in the Archean land.

The ice period so obstructed the old outlet that when it was melting, the superfluous waters of the great basins were poured into the Gulf of Mexico through the Illinois and Wabash rivers. When the ice disappeared, the old outlet had become obstructed by flexions of strata and mountains of drift. It is evident that Lake Michigan had a channel through Georgian Bay, and thence into Ontario. It is not yet apparent where the deep channel for the waters of Superior came in, or that it had any such. It has an insignificant but sufficient outlet through the St. Mary's River. Michigan and Huron reach Ontario over the St. Clair flats and through the shallow trough that holds Lake Erie, which probably is of post-glacial age, and then into Ontario down the hill that is being cut back by the falls of Niagara.

The great lakes were deep seas before the world was cold enough for ice, and were great basins before glaciers were possible.

One could hardly conceive how glacial ploughing coming from the north or north-east could make chasms at such angles to each other. In regard to cut of channels of erosion, it would require a river from the south-west and north-west, from Michigan and Superior, of such magnitude that great valleys or traces of them would be left. Lake Superior is 360 miles long and 150 miles wide in some places, with a

depth of 1000 feet, with a probable 100 or 200 feet more covered with sediment 600 feet above tide-water, which would make its bottom 500 feet below sea-level. To conceive it as an old river channel would require an elevation of the continent of 1500 feet above its present level. It is, moreover, surrounded by high rocky shores having few rivers coming into it, as its watershed was never large and not channeled by fjords.

There may have been an elevation of the continent, but the lakes went up with it; there was undoubtedly ice but the lakes were there before it. They are pools left by the old Azoic Sea.

Clinton, Iowa.

NOTES AND NEWS.

IN the latest quarterly statement of the Palestine Exploration Fund as we learn from *Nature*, it is said that considerable progress is being made with the Akka-Damascus Railway, the route of which, after various expensive surveys, has been definitely decided upon. The line chosen is practically that first suggested by Major Conder, R.E. several years ago. Beginning at the great fortress of Acre, the railway will run down the plain of Acre parallel with the sea, throwing out a branch to Haifa, at the northern foot of Mount Carmel, and thence to and across the plain of Esdraelon, passing near Nazareth to Shunem and Jezreel, and through the valley of Jezreel, skirting the slope of the hills, to the river Jordan, which will be crossed within sight of Bethshean. The Jordan here offers exceptional facilities for the erection of the railway bridge, consisting of two spans. Not only are the two opposite banks of the river formed of solid rock, but the centre of the river contains a large block of similar rock, from which each span of the bridge will be thrown to the east and west bank respectively. From the Jordan the railway will ascend the slope of the Jaulan Plateau, along the crests that close the eastern shores of the Sea of Galilee, this ascent constituting the only difficult portion of the line, but which the surveys now made show to be much easier of accomplishment than was originally anticipated. The plateau near El'Al being reached, an easy gradient will carry the line by Seil Nawa and Kesweh to Damascus. Passing through the finest plains of western and eastern Palestine, the railway will be one of great importance. The authorities of the Palestine Exploration Fund are of opinion that its construction can hardly fail to lead to important archæological discoveries, and the committee hope to make arrangements for obtaining full information respecting these.

— The *Kew Bulletin* for May and June, according to *Nature*, contains several contributions which will be of great interest to botanists and to various classes connected with the industrial applications of botany. One of these contributions is a valuable report (with a plate) by Mr. George Massee on a disease that has attacked vanilla plants in Seychelles. In the same number are printed the second of the Decades Kewenses Plantarum Novarum in Herbario Horti Regii Conservatarum, and the second decade of new orchids. An excellent illustration of the way in which the authorities at Kew seek to promote industry is afforded by a correspondence on Sansevieria fibre from Somali-land. The increased attention devoted to the production of white rope fibres in the western tropics appears to have had a stimulating effect in the East Indies, and now the production of fibre from *Agave vivipara* in Bombay and Manila is followed by a fibre obtained from Somaliland from a singular species of Sansevieria. This fibre was first received in this country as an "Aloe" fibre. It was soon noticed, however, that it possessed characteristics differing from all ordinary "Aloe" fibre, and a request was made to the Foreign Office that Colonel Stace should be invited to obtain for the Royal Gardens a small sample of the fibre, a large leaf from the plant yielding it, and, if possible, a few small plants for growing in the Kew collection. In due time the specimens arrived in excellent order, and it was found that the fibre is one of the many so-called Bowstring Hemps, and probably yielded by *Sansevieria Ehrenbergii*, a plant first collected by Dr. Schweinfürth. Little or nothing was known of it until it was described by Mr. J. J. Baker, F.R.S., in the Journal of the Linnean Society, Vol. xiv., p. 549. Its locality is there stated as "between Athara and the Red Sea." The plant is described in a letter to the Foreign Office, written by Mr. D. Morris, as a very interesting one, and he adds that its existence as a source of a valuable supply of fibre will be sure to awaken attention among commercial men in Great Britain. Messrs. Ide and Christie, writing to Mr. Morris, speak of the fibre as an excellent one of fair length and with plenty of "life." "In character," they say, "it strongly resembles the best Sisal hemp, with which we should have classed it but for your statement that it is derived from Sansevieria. With the exception of its color, its preparation is perfect, and, even as it is, we value it to day at £25 per ton. We are of opinion that if care were taken to improve the color a considerably higher price would be readily attainable, perhaps as much as £50 per ton, if a pure white fibre could be attained without loss of strength and lustre."

— The Harvey process of case-hardening, which has been so successfully applied to giving a hard surface to armor plates, is carried out as follows, according to *Engineering:* The plate to be treated is made out of mild steel, containing, say, 0.10 per cent to 0.35 per cent carbon, and, after being formed to its final shape, is laid flatwise upon a bed of finely-powdered dry clay or sand, which is deposited upon the bottom of a fire brick cell or compartment erected within the heating chamber of a suitable furnace. The upper surface of the plate is then covered with powdered carbonaceous material, which is tightly packed. Above this is a layer of sand, and over the sand is laid a heavy covering of fire-bricks. The furnace is then lighted and raised to a temperature sufficient to melt cast-iron, and this heat is maintained for a greater or lesser period, according to the amount of carbonizing to be effected. About 120 hours are said to be required for a plate 10½ inches thick. On removal from the furnace such a plate is found to have had the composition of its upper surface changed. At a depth of about 3 inches from this surface the percentage of carbon has been raised by about 0.1 per cent, which increases progressively as the outer surface is neared, when the amount of carbon may rise to 1 per cent. It is said that this process, though, as will be seen, it resembles the ordinary cementation process, does not cause any blistering of the surface of the plate. This the inventor attributes to the high temperature at which it is carried out; but it is also suggested that the absence of blisters may be due to the homogeneity of the metal used, which, unlike the wrought-iron bars used in the cementation process, is free from cinders.

— An interesting addition to the much-vexed Sumero-Akkadian question has recently been made by an Ottoman scholar. Ohannes Sakissian Effendi, an official in the Treasury department at Constantinople, has issued privately the first instalment of a work intended to prove that the non-Semitic idiom of the cuneiform inscription is related linguistically to Armenian, Turkish, and ancient Egyptian. He strenuously combats the theory of the Rev. C. J. Ball, of the affinity of Akkadian and Chinese. That Akkadian or rather Sumerian was related to Turkish or to Armenian is by no means inherently improbable. We can hardly admit being convinced by the author as yet, and would prefer awaiting some ethnologic evidence before reaching a conclusion. But we cannot fail to welcome to the ranks of students of the ancient civilization of Mesopotamia the first subject of the Empire of which Mesopotamia is a part, who has busied himself with cuneiform studies. Turkey has produced investigators in all branches of modern science, a classical archæologist and explorer like Hamdi Bey, a Turkish lexicographer like the late Ahmed Vefik Pacha, or a man like Tewfik Bey Ebuzzia, the historian of Turkish literature, a writer on military matters like Djeva Pasha, the present Grand Vizier, or a student of pure mathematics like Tewfik Pasha, the present minister of public works. Sakissian Effendi is the first Ottoman who, to our knowledge, has written on a subject connected with cuneiform research, and we take the appearance of his brochure as an omen that these studies will be seriously taken up at the Imperial Museum in Constantinople. A catalogue of the cuneiform objects preserved in that museum would be eagerly welcomed by the learned world.

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THE HOPKINS SEASIDE LABORATORY.

BY DAVID S. JORDAN.

ONE of the best equipped and most favorably situated of the marine laboratories for research is the Hopkins Seaside Laboratory on Monterey Bay in California. This institution is an outgrowth from the biological departments of the Leland Stanford, Jun., University, its equipment having been provided for by the generosity of Mr. Timothy Hopkins, one of the trustees of the University. The laboratory is situated on a rocky point of land known as Point Aloha, which juts into Monterey Bay near the village of Pacific Grove. The laboratory is a two-story, frame building sixty feet by twenty. On each floor the many windows make the sides of the building virtually of glass. The lower floor is devoted to aquaria and to work in connection with aquaria. The upper floor is fitted up for advanced research, with private rooms for workers in special fields. On the lower floor are seven aquaria provided with running water, besides various glass jars and similar vessels used for the study of smaller animals.

The fauna of Monterey Bay is peculiarly rich, as the life histories of the animals of this region have been scarcely studied by zoologists. The laboratory, therefore, offers special attractions to naturalists, particularly to workers on tunicates, jelly fishes, star-fishes, fishes, and nudibranch mollusks. The material for zoological purposes is extremely abundant, and one singular feature of the life of this region is the immense size to which many animals grow as compared with the size reached by their relatives in the Atlantic.

In the aquaria I notice many specimens of salpa, large transparent tunicates, reaching a length of four or five inches. There are nudibranch mollusks (*Aplysia*) nearly a foot in length, and a twenty-armed star-fish (*Pycnopodia*) whose span covers the whole height of one side of the aquarium. This creature has been timed in making a circuit of the four sides of the aquarium, covering the distance of about nine feet in just four minutes. Immense jelly fishes which will almost fill a bushel basket are also very common, and sea anemones, reaching a size by which the largest of the Atlantic seem like marigolds compared with sunflowers. Tunicates, chitons, limpets, sea urchins, sea anemones, octopus, and squid exist in great abundance and variety. Among the fishes are also many forms of interest in the aquaria, numerous species of blennies and sculpins abounding about the rocks. The blue hag-fish (*Polistotrema*) occurs in great abundance. This is an eel-shaped fish about a foot to a foot and a half in length, which lives as a parasite in the bodies of other fishes. It enters at the eye or at the throat or some other soft place, and then by means of the rasp-like teeth, makes a hole in the body of its host and in time without breaking or disturbing the bones or viscera of the unfortunate animal, it will devour the entire muscular system of the fish on which it feeds. Many of the larger flounders and like fishes obtained in the Bay of Monterey are found to be half-devoured or reduced to mere hulks by the operation of this singular fish. The locality is especially favorable for the study of the viviparous surf-fishes and rock-fishes. The huge torpedo or cramp fish, which is found across the bay about Soquel, also invites investigation. As I write, a grampus 12 feet in length is brought in in a dray-wagon by a Portuguese fisherman from Monterey, while a constant stream of objects of interest comes in from the Chinese fishing camp at Point Alones. The marine flora of the Bay of Monterey is equally interesting. About one hundred and twenty species of sea weeds have been collected by Mr. Bradley M. Davis, who has charge of the work in botany. These range in size from the giant kelp, which here has a length of thirty or forty feet, down to the minute algæ about the wharves.

The laboratory is well supplied with collecting apparatus, with microscopes, reagents, embedding apparatus, and the usual material for study, this being brought from the laboratories of the Stanford University. About thirty students have been in attendance during the summer, some of these being advanced workers in different departments, some of them teachers and the others students from the laboratories of the university.

Among the pieces of special work which may be noticed are the studies of Professor Frank M. MacFarland on the egg segmentation of the nudibranchs, those of Frank M. Cramer on the nervous system of the limpet, those of Leaverett M. Loomis on the sea birds of Monterey Bay, those of Wilbur W. Thoburn on the rock-fishes, those of Miss Flora Hartley on the anatomy of the abalone, and those of Mr. Charles W. Green on hydroids.

The instruction for the summer has been in the hands of Professors Charles H. Gilbert and Oliver P. Jenkins, of the chairs of zoology and physiology respectively, in the Stanford University, assisted by Bradley M. Davis and Wilbur W. Thoburn, graduate students. The purposes of the laboratory as set forth in the circular are: To supplement the work given in the regular courses of instruction in the zoological, botanical, and physiological departments of the university under the favorable conditions of such a station; to provide facilities for investigators who are prepared to make researches in marine biology, for which the Pacific Coast offers exceptional attractions, in that its field is very rich and is as yet largely unworked, to afford an opportunity to those, especially to teachers, who desire to become acquainted with marine animals and plants, and to learn the practical methods of their study.

In respect to the abundance of material and newness and freshness of the fauna to be studied as well as in the matter

of comfort and convenience of living, there are none of the seaside laboratories which are so fortunately situated as the one at Pacific Grove.

The views from the windows of the laboratory are singularly picturesque and attractive. On the east is seen the long curve of Monterey Bay, bordered by white sand-dunes covered with deep green chapparal, the dark pine trees of Pacific Grove, and the rocky promontory of Point Alones with its Chinese fishing camp in the foreground, and in the distance the mountains which separate the valley of Monterey from that of San Benito. On the west the irregular coast-line is visible as far as the point of pines, and on the north the broad sweep of the bay-shore is in sight as far as the lighthouse of Santa Cruz. The Bay of Monterey, with its surroundings of rock, forest, and mountain, is one of the most picturesque in the world, and to the eye of the naturalist it has no equal, at least short of the coral-lined harbors of the tropics.

THE ANTENNÆ AND STING OF YIKILCAB AS COMPONENTS IN THE MAYA DAY-SIGNS.

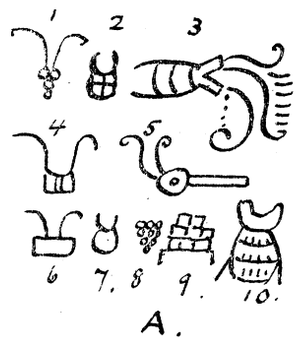
BY H. T. CRESSON, A M., M.D.

BEE-CULTURE among the ancient Mayas seems to have received considerable attention, and the apiarists, we are told, had patrons, — the *Bacabs*, — one of whom, called *Hobnil*, was in especial favor. It was in the month Tzoz that the bee-keepers began to prepare themselves for their celebration in Tzec, and the four Chacs were at that time presented with plates of incense, one for each Chac, the borders of which were painted around with designs representing the honey-comb.

The species of bee which prepared the celebrated honey of Estabentûm, from a white flower resembling our jessamine, is like the common bee of Europe in shape and size, and differs from it only in having no sting; it is in fact the bee of Yucatan and Chiapas, and the honey which was prepared, especially during the month when the Estabentûm bloomed, was much sought after in early times, and no doubt formed an important article of commerce between the inhabitants of *Maiam* and the island that is now called Cuba. Four or five other species of bee are said to exist in Yucatan, but, with a few exceptions, their productions are inferior to the bee common to that country and Chiapas.

That the honey-bee was highly esteemed by the ancient Mayas there is but little doubt; for we see this industrious insect represented in various portions of the "Bee-Keeper's Narrative" of the Codex Troano, while honey in the comb is represented by the Maya scribe as square cakes of that material (see Fig. 9, plate), carried in the hand of the "god with the old man's face,"— so named to distinguish him from other gods who were represented in the same narrative. Honey is represented by other hieroglyphs, one of which, shown in Fig. 8 of the drawing, has an especial connection with the antennæ sign, and we will presently refer to it. If our alphabet interprets with a reasonable degree of exactitude, we suppose the god with the old man's face to be Kukuitz, who appears in one of his various characters as the patron of the bee-keepers. The phonetic components of the hieroglyph which invariably accompanies this god, suggest this interpretation. In front of the glyph we have components of the day-signs Chuen and Akbal enclosed in the dotted aspirate circle, while below it are Landa's aspirates twice, and even in some cases thrice repeated. This gives us "chu-chu" or "khu-khu." Within the glyph, surrounding the eye, is the scroll which is always present in this god's glyph, and to us suggests the phonetic value of *ix* or *itz*. The c^{h}i glyph is generally placed underneath what we have assumed to be used as a determinative; the two round glyphs on either side of the tooth-like projections inside of the c^{h}i glyph suggest that in this case it is to be used as Chu. I find this c^{h}i glyph appearing as chá, chā, c^{h}i, cho, chu, a determinative being generally added to suggest which is to be used, whether it be á — ā — i — o — u. An example of one of these supposed determinatives will be given further on in this paper.

The sting of the bee is used in the day-sign *yk* or *ik* (see Fig. 7 of drawing), and appears quite frequently in glyph form in the Troano, also in Landa's day-signs and those of the Chilan Balaam of Káua, and is attached to the body of the *ahaulil-cab*, who so frequently appears in the Troano with body erect as if ready to strike with her stinging apparatus (Fig. 10 of drawing). It can readily be seen that this sting is but a variant of that used in the day-sign *ik* (Fig. 7 of drawing). It can also be seen attached to the right-hand side of the head-dress of the goddess *Cab*, second division of plate 25, Codex Troano. The end of the bee's abdomen and the stinging apparatus (Fig. 3 of drawing) is somewhat square like those of the Codex Troano (Bee-Keeper's Narrative); but it is easily recognized as a variant of glyphs 7 and 10 of our drawing. The determinative ending is placed just beyond the stinging apparatus, and is composed of the *i* loop and *kil;* the dotted aspirate also appears, and the *há* glyph is the parallel line running out from the *il* curve — "ish-kil-há" is thus expressed, an admirable suggestion of "*Ikilca*" (*b* is understood).



The antennæ of the bee appear in the day-sign Cauac; in fact the signs *yk* (or ik), *Cauac*, and *Caban*, all have the sting and antennæ of the bee as components. This connection will be more apparent by reference to Dr. D. G. Brinton's study of the "Books of Chilan Balaam," pages 16 and 17. The day-sign 13 Caban, in the Chilan Balaam of Káua, has the antennæ of the bee for its components, and 2 *Cauac* and 5th *ik* have the antennæ and sting, one more component appearing in 2d Cauac than in 5th *yk*. These same signs in the Landa and Troano columns of Brinton's plates have the honey signs, and the antennæ and hive, all used as phonetic components of the glyph, that of Landa and the Codex Troano rendering the word *ikilcab* with great simplicity. It is expressed thus, "x-il-cab," the dotted *sh*, or *x* aspirate, being added to assist the reader in obtaining the correct interpretation. The *Cauac* glyph also appears in the bas-relief of Kukuitz, the left-hand slab alongside of the doorway, Casa No. 3, Palenque. By placing a lens on a good photograph of this masterpiece of the scribe sculptor's art, the antennæ of the bee can be seen attached to the honey-sign (Fig. 1 of the drawing shows this glyph), the antennæ being at-

tached to the honey-sign. In the more demotic *Cauac* glyphs, honey is represented as shown in Fig 8 Erosion has partially destroyed one of the components of the Casa No. 3 *Cauac* glyph of which we speak, but by comparing the photograph with Catherwood's drawing, it will be found to closely resemble this component in the demotic *Cauac* glyph. It is simply the aspirate circle (dotted), enclosing two small squares as in the Landa glyph of Cauac. In this connection it may be interesting to add that an attempt to interpret, by means of our alphabet, the inscription at the top of the left-hand slab, Casa No. 3, Palenque, gives as follows: "The gods — earth — sky — water — maize — Kukuitz and Kukulcan — Cauac — Muluc." The slab at the right-hand side of the doorway of Casa No. 3 we think represents *Kukulcan* with the wart-like excrescence and the antennæ sign attached to his forehead. The inscription, according to the rendering of our alphabet, reads "Kukulcan, u-ahkin imix, ah-Cimil, Chikin." The forefinger of the left hand of Kukuitz on the left-hand slab of Casa No. 3, Palenque, points to a glyph just above, which is probably the hieratic glyph of this god, bearing, we think, strong affinities to the demotic character, an attempt at the analysis of which has already been given in this paper. Just above the Kukuitz glyph, in the perpendicular column in front of the god's face, is *Chikin*, above Chikin is *Ahau*, the next two glyphs not yet determined, and then immediately below the horizontal line of glyphs in the right-hand corner of the slab is *Cimi*. Just above *Cimi* is *Kan*, and to the left *Ikilcab;* the third to the left on this parallel line of glyphs seems to be the long-nosed god — probably *Kukulcan* — next to it *Itzamna*, and the end glyph on the left seems to express "Itza." This interpretation is made subject to further alteration and improvement; to give detailed analyses of these glyphs in a short paper is impossible.

The small figure on Plate 25 of the Codex Troano (*b*), turned head downward, shown in drawing B, has some interesting relations with the antennæ glyph attached to the honey-sign (see Figs 1, 4–6, drawing A — 1 and 6 = hieratic script, 4 = demotic). The drawing B is but a portion of the original design of the scribe, the hand supporting the antennæ sign, enclosed in the circular glyph underneath the upturned foot, is that of the goddess *Cab*, or the earth. Just above the antennæ glyph (phonetic value = i-kil-cab) is the foot which = *uoc*. The hand of the goddess supporting this design is the $c^{h}i$ glyph, but in this place it has the phonetic value of *Chá*, the *há* determinative being quite conspicuous on the thumb, its end protruding well into the circle enclosing the antennæ glyph. This obtained, we have suggested "chá-uoc" or *Cauac*.

The *ca* glyph in the eye of the child figure and the foot also give us, *cauoc* a repetition of *cauac*. The antennæ of the bee with the slight *i* curve at the end give the phonetic value *ikil*, and the honey squares below give us *cab* = *ikil-cab*. There is evidently some close connection between *cauac* and *ikilcab*, for the head-dress of this child figure has the scribe's method of representing honey by squares and suggestions of *ikil*. The work of the scribe sculptor was necessarily different from that of his more demotic brethren, who drew the more cursive script, yet there seems to us to be a not improbable relationship of this figure on Plate 25 of the Troano to that upheld in the arms of the *ahkin* on the Casa No. 2 group — Palenque. The peculiar slit or deformed feet and variants of the head-dress suggest that future study may show some connection between these figures, and that *ikilcab* and *cauac* may have a dual meaning or personality. Mr. W. Thomson, who has been residing in Chiapas for many years, informs me that during a visit to Lorillard City his Maya servant, who had been a bee hunter in his youth, accompanied him, and while they were preparing a resting-place for the night the cry of a jaguar was heard; the old man shook his head, and laying his hand on a sculptured lintel near the door of the temple, said rapidly "The jaguar calls, the bee leaves the centre of the maize flower and seeks the hollow tree," then turning toward the bas-relief he indicated the head covering of the figures ejaculating "*cab*," then as if startled at what he had said, he relapsed into silence, and no amount of questioning could obtain anything further from him. I cannot recall where I have read it in one of Dr. Brinton's books, but he mentions that Dr. Berendt while travelling with a Maya guide overheard some remark which he made having an interesting meaning, but the man, recollecting that he was accompanied by one of the white race, stopped short in his words and nothing further could be elicited from him. The suggestion of *cab*, a hive, was an excellent one, for the head coverings of these

B.

figures, as represented by Charnay on page 391 of his "Villes du Nouveau Monde," seem to be representations of bee hives; and it was the antennæ sign to the right-hand side of the large figure on this slab, or lintel, that led my learned friend to make the suggestien that the antennæ, attached to the sign for honey, might possibly exist on other sculptured Maya reliefs. As I have stated, it exists in the manuscript Troano (see Plates 24 and 25), and a sculptured slab in the Smithsonian Institution has it represented by an incised square, to which the antennæ are attached (see *A*, Fig. 6). It is the most demotic form of the hieratic-scribe-sculptor's work that I have examined. The glyph in question is to be seen on a cast which is now hanging on the stairway-wall of the Smithsonian Institution at Washington, to the right-hand side of the long gallery in which Professor Thomas Wilson has arranged his interesting synoptical cases. No record is attached to the cast, but by its character and technique it seems to be a copy of one of Charnay's squeezes, probably from Lorillard City. The antennæ glyph frequently appears near representations of corn leaves, and as we have the day-signs *Ixim* and *ik*, the latter, there is but little doubt, being but an abbreviation of *ikil* = the sting

(the sign used for this day is the bee sting), there is evidently a connection between *ymix*, *ik*, *caban*, and *cauac*, whose components are all more or less associated with, or composed of, the bee and honey signs.

When I speak of the components of a glyph it may be that an example will make this more readily understood. Take the day-sign *manik*. We have in this glyph, as represented by Landa, four components; the first is the glyph not unlike a carpenter's T-square which has the phonetic value of *ma;* near it to the right are three short lines which = *n;* and below to the left is the *ich* or *ix* glyph, which gives us, together with the others, "Ma-n-ich" — an excellent suggestion of Manik. The day-sign, *chicchan*, was represented by a pot, the base of which was crossed by hatchings giving the phonetic value *x;* the white space at the end of this divides the hatching from a black line, to which tooth-like processes are attached, giving the phonetic value of "*há-ch.*" We now have *x* or *sh*, which, joined to *há*, = *xá;* placing *ch* before this we obtain "*ch*-xa" — the suggestion of "Chi-xa" or "chicchan." The hieroglyph of the day-sign *Ahau* contains as components the á glyph, from which perpendicular lines mount to the top of the circle enclosing them. The straight lines = *há*, and the two small round circles on either side of the há = oo, giving us "Ah-há-oo" or "Ahau." The phonetic components of Landa's B are simply expressed by conventionalized footmarks = *be* in Maya; and when Landa asked for *bay* (the way he pronounced it in Spanish), the Maya scribe jotted down representations of footprints which recalled to him the sound of the name of the thing represented — in other words *be* — pronounced bā in Maya.

I believe the standard of phoneticism in these old Maya glyphs to be about the same as the more advanced system of writing used by the Nahuatalacs, and described by M. Aubin. The phonetics of some of the Maya day signs are quite obscure, others quite clear and easily interpreted.

The scientific world is already coznizant of the painstaking labors of Professor Cyrus W. Thomas of the Bureau of Ethnology, and his researches upon the Codex Troano are of inestimable value. I have recently had the pleasure of working in conjunction with Dr. Thomas as a member of the staff of the above-named institution, and I am convinced that his alphabet is based upon a solid foundation. Although we are both working by independent methods of research, like results have been obtained in several cases by repeated tests. His recent publication in *Science* adds other similarities of interpretation; surely this correspondence of results cannot be the result of accident. Dr. D. G. Brinton, Professor of American linguistics and archæology in the University of Pennsylvania, in a recent letter, says, "The correspondence between your interpretations and that of Professor Thomas in certain cases is strong *prima facie* evidence that both methods are based on correct principles." I have but to repeat Dr. Thomas's words "that this agreement in our conclusions . . . serves to strengthen both in the conviction that we are making genuine progress in the solution of this difficult problem."

"THE Optics of Photography and Photographic Lenses," by J. Traill Taylor, editor of the *British Journal of Photography*, is a useful little volume for those who desire to master the optical principles involved in the construction of photographic lenses. The work is also of value to the practical photographer, as it gives directions for the proper use of diaphragms, for the testing of lenses, etc.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

The English Sparrow and Other Birds.

I HAVE often read accounts of the English sparrow driving out our native birds, and for several years have been watching closely to see what the truth is; and from my observations I must conclude that many persons write facts from imagination.

That matters may be better understood, I may state that for twenty-three years I have lived on Ohio Street, the principal business street of the city, between 9th and 10th streets; this being near the centre of the city, the business buildings extending on Ohio Street half-way between 7th and 8th streets, and the residences having considerable ground around them, with many shade trees from fifteen to twenty-five years old.

The English sparrow came to Sedalia about twelve years ago, and for a long time did not get away from the vicinity of the business centre. Some five or six years ago, during a severe winter, I saw them one time only as far out on Ohio Street as Broadway or 8th Street, to which point they had come hunting something to eat on the street. The following summer they were frequently seen on the block between Broadway and 9th Street, but came into my yard only a few times. The following summer they were frequently in the yard, but made no nests. Since that time they have built their nests in the yard, and have fed in large numbers in the chicken-yard.

The trees are now large enough and dense enough to furnish protection for birds, and of late years more kinds are found in the city than formerly. The blue jay stays the year round, and during the winter as well as summer the red bird and some other kinds are frequently seen. In summer the tree black bird, the robin, the cat bird, the rain crow, or cuckoo, and the wren are abundant, and make their nests. In addition to these, the brown thrush, the mocking bird, the red-head woodpecker, the red-head flicker, the sap-sucker, and other kinds are often seen, some of them daily.

Now, which of all these birds has been affected by the sparrow? Not a single one of them. They are all as abundant as they were five years ago, or at any time in the past, and much more so than they were ten to twenty years ago, before there were as many trees as there are now.

In addition to the birds mentioned, I might name three others. The town martin has always been in the city in great numbers, making their nests in all kinds of cavities around the houses in the business part of the city. These same places were taken possession of by the sparrows; and they being here the year round, and making nests even in the winter time, the places belonging to the martins were appropriated before their arrival, and when they came they had to fight to recover them. I was much interested in watching one of these fights. Across the roof of a one-story building next to my office, and in the top of the adjoining building, a martin had found a hole, and had appropriated a place within for a nest. A sparrow had also afterwards done the same, and was found in possession when the martin arrived from its winter pilgrimage. The latter at once gave fight, and time and again during their fight they would fall to the roof below, and were so intently engaged that more than once I had my hand almost upon them before they would let go of each other. The martin won the fight, and the sparrow gave up the nest it had taken.

As I now sit in my yard the martins are circling overhead by the hundred, they staying during the day in the business part of the city. It is very evident that the sparrows have not run the martins out, although they are direct competitors for the same nesting places.

Years ago the chippee always made its nests in my yard, but has not done so for six years, except in one case, and that nest was abandoned without being completed. I do not know the reason; I imagine the English sparrow domineers over the little

chipping sparrow, but still the latter quit nesting in my yard before the former commenced.

I put up boxes which were formerly occupied by bluebirds. As soon as the sparrows nested in my yard they took possession of these boxes; and when the blue birds came they did not have the grit or strength to turn the intruders out, and they went elsewhere to nest. After nesting time they are seldom seen in the city during the summer. Very clearly the sparrows have driven the blue birds out of this part of the city, and possibly the chippees; but if they have affected any other kinds, my obervation has not been keen enough to detect it, though I have had my attention directed to it for years. F. A. SAMPSON.

Sedalia, Mo., July 25.

On Maya Chronology.

IN a former communication, answering Professor Cyrus Thomas's "Brief Study of the Palenque Tablet," I stated that the theory brought forward by Professor Förstemann, that the Dresden Codex does not count the days from the first of the given month but from the last of the preceding month, is to be put aside. Professor Förstemann's theory is based on the supposition that the calendar system of the Dresden Codex was the same as that which prevailed in Yucatan at the time of Bishop Landa's writing. This supposition, however, is an erroneous one. In the "Zeitschrift für Ethnologie," Vol. XXIII., I have shown that the priests who wrote down the Dresden Codex did not begin their years with the signs *kan, muluc, ix, cauac,* as in Landa's time, but with the signs *been, e'tznab, akbal, lamat,* exactly corresponding to the signs used by the Mexicans to designate their respective years. Beginning the years in this manner, the day 4 *ahau*, 8 *cumku*, is really the eighth day of the month *cumku* in the *been* or "cane" years, and conformingly all the other dates throughout the whole Dresden Codex.

I wish to call attention to a passage of the Chilam Balam of Mani which seems to confirm my opinion. It is said there (Brinton, Maya Chronicles, p. 98): "In the Katun, 13 *Ahau,* Ahpula died. It was in the course of the sixth year before the ending of the katun, as the counting of the years was in the east, and (the year) 4 *Kan* seated upon the throne, on the 18th day of (the month) *Zip,* on the day 9 *Fruix,* Ahpula died." Now it occurs only when beginning the count with the first day of the month, that a day 9 *Fruix* is the 18th day of the month *Zip.* And, indeed, in the year that begins with the day 4 *Kan,* the day 9 *Fruix* is the 18th day of the month *Zip* — beginning the count with the first.

Here, therefore, we have the same designation of a date by the sign of the day and the position it holds in the number of twenty, or a Maya month, as in the Dresden Codex. It seems scarcely probable that the natural manner of counting seen in the passage of the Chilam Balam, quoted above, should be replaced in the Dresden Codex by another and wholly unintelligible one.

DR. ED. SELER.

Steglitz, July 24, 1892.

The Palenque Tablet.

ALLOW me to say in reply to Dr. Seler that I did not "follow Dr. Förstemann" in regard to the peculiar method of counting days in the Dresden Codex. I had discovered this peculiarity before I was aware that anyone else had noticed it, and have now an unpublished article on the series, — Pls. 46–50, — based on that method, which was prepared some time ago. While at work on this paper the thought occurred to me that the series might be based, as Dr. Seler supposes, on a calendar in which the years commenced with *Been, Ezanab, Akbal, and Lamat,* and a table was prepared on this theory.

I quote from that paper my reply to the suggestion. After noting the fact that the count began with the last day of the month, I remark, "It might be argued from this that the years and months began with what have been considered the last days, but for the fact that all the historical evidence is against such a conclusion, and, as can be shown, a full and complete explanation of this series can be given without resorting to this theory."

There are also some difficulties in the way of this theory. Pushing back the series one day is a very simple process; but it will sometimes throw dates in the five added days which do not belong there, and would break the continuity of the Katunes and cycles. Moreover, I think this custom of counting from the last day of the month will explain the reason for commencing the numbering of the Katunes with 13.

I think it quite probable that, if Dr. Seler will attempt to trace out on his theory the three long series on Plates 46–50, each running through 104 years, he will find that it will fail to work. If not, then it is immaterial, except as regards the succession of the epochs, whether we count the commencing days the last or first of the month.

As this theory is wholly unnecessary to explain the peculiarities of this Codex, and as Plates 25–28 appear to be based on the method of counting from the last day of the month, I see no good reason for adopting it.

Dr. Seler thinks my statement that day-numbers were not attached to month-symbols on Plates 48 and 50 of the Dresden Codex when the number was 20, is erroneous, and calls attention to certain characters which he believes are symbols for this number. The little characters he alludes to are certainly present, and, as they are not parts of the month characters, may be intended to denote the fact that the month is completed. But it is difficult to explain on his supposition the fact that the symbol on Plate 48 to which this sign is attached is that of the month *Yax,* when the date is 11 *Eb,* the twentieth day of *Chen;* and one of those on Plate 50 is the symbol for the month *Pop,* when the date is 11 *Ik,* the twentieth day of *Cumhu.* In other words, the symbol in each case is of the month following and not that to which the twenty days apply. His explanation therefore fails to solve the difficulty, and cannot as yet be accepted as fully satisfactory; nevertheless, it must be admitted that these added characters have some reference to the completion of the month.

His interpretation of the open-hand symbol by *pax,* "to beat," appears to be erroneous, as there is nothing connected with it representing the phonetic element *p.* CYRUS THOMAS.

Smithsonian Institution, Washington, D.C.

BOOK-REVIEWS.

On the Modification of Organisms. By DAVID SYME. Melbourne, George Robertson & Co. 8°.

ON account of the many questions dealt with in this book, it is difficult to do justice to its contents within our limits. The prime object of Mr. Syme's clearly-written and forcible work is to show the falsity of the theory of natural selection, and to present another hypothesis to explain the cause of the modification of organisms. The greater part of the volume is taken up with criticisms of Darwin's statements and method of exposition, and the author's ideas as to the true cause of modifications are not brought forward till near the close of the work.

They are embodied in what may be styled the doctrine of "cellular intelligence." "The cell is the biological unit," Mr. Syme asserts. "It is the irreducible vital entity; it is the seat of life and energy; it is the key that unlocks the mystery of organic modifications" (p. 142). But it is more than this. It is the element which "feels, thinks, and wills" (p. 144). In other words, it is intelligent.

Startling as this doctrine is, the author does not hesitate to claim for it a wide application. In the movements of the stamens and pistils of flowers, the selection of grains of sand by rhizopods, and the healing of wounds, he sees the operation of this "cellular intelligence."

Modifications of organisms are brought about by the stimulating influence of external conditions. "These conditions, if uniform, pronounced, and prolonged, will, according to their nature, invariably incite the organism to change in a definite direction." Mr. Syme holds that modifications result from the action of the organism itself and not from any direct influence of environment. Hence he rejects the terms "use" and "disuse," which mean only "function and its absence," and prefers to say that modifica-

tions occur in accordance with the law of "effort and abstinence."

As to whether acquired characters are inherited, Mr. Syme offers no definite opinion; and hence the most important question in this connection remains unanswered. For, if modifications resulting from the response of an organism to new influences affect only the passing generation, it is difficult to understand how they can become fixed, as they certainly do.

It should be stated further that Mr. Syme avows a belief in the existence of "vital force," which is the cause of the phenomena of life and is inherent in the living cell. He asserts that Lewes's ridicule of this idea was due to his misunderstanding the questions involved.

Our space does not admit of more than a brief mention of Mr. Syme's objections to the theory of natural selection, but many of them deserve serious attention. The case of the relation of humble-bees to clover may be cited as an example. Darwin states that "humble-bees alone visit red clover, . . . hence we may infer as highly probable that if the whole genus of humble-bees became extinct or very rare in England, . . . the red clover would become very rare, or wholly disappear" (Origin of Species, Ed. 1880, p. 57). On this point Mr. Syme remarks: "Darwin says that *T. pratense* will not produce seed unless it has been visited by humble-bees. . . . But this is quite a mistake. Red clover seed had been grown and exported from New Zealand long before the humble-bee was introduced there; and I am informed by one of the leading Melbourne seedsmen that he has been supplied with this seed, grown in the western district of Victoria, for the last 17 years; although no humble-bees have ever been introduced into that colony" (p. 112). It does not seem possible that both these statements can be true.

Many similar facts regarding the relation of insects to the color and form of flowers, the results of cross-fertilization, and the significance of secondary sexual characters, are cited by Mr. Syme in his endeavor to prove the falsity and insufficiency of the theory of natural selection. F. W. T.

The Apodidæ. A morphological study. By H. M. BERNARD. *Nature Series.* London and New York, Macmillan & Co. 8°. $2.

THIS is an extremely interesting study of the Phyllopod crustaceans, *Apus*, *Lepidurus*, etc., with the view of using them as a key to solve the problem as to the origin of the crustacea and the true affinities between the different groups. His study has led the author to the conclusion that *Apus* is derived from a carnivorous annelid, whose five anterior segments have become ventrally bent over. He believes he has shown the trunk of *Apus* to be a true link between the many segmented annelids and the crustacean fewer-segmented body, that it exhibits a gradual transformation of the annelidan cuticle into the crustacean exo-skeleton, while the annelidan parapodia are shown to be capable of developing every form of crustacean limb, *Apus* supplying the clue. In short, he regards *Apus* as affording an almost ideal transition form between the annelids and crustacea. Further, he shows that if this is true for *Apus*, the long-contested *Limulus* or horse-shoe crab and the Trilobites must have had a similar origin. He concludes that while only one group of modern crustacea admits of derivation from the Trilobites, all the rest except *Limulus* can be deduced from the *Apodidæ*.

Whether this hypothesis be finally accepted or not, the author's discussion throws light on many contested points, and cannot fail to have a beneficial influence on future discussions and theories of classification of the animals to which it relates.

Lessons in Elementary Biology, By T. JEFFREY PARKER. London, Macmillan & Co. 8°. $2.25.

PROFESSOR PARKER, a well known pupil of Huxley and professor of zoology in the University of Otago, New Zealand, has endeavored in this work to give an account of the structure, physiology and life history of a series of typical organisms in the order of their increasing complexity. He begins with the unicellular organisms *Amœba*, *Hœmatococcus*, *Heteromita*, *Euglœna*, *Protomyxa*, *Mycetozoa*, *Saccharomyces*, and *Bacteria*. He then takes up those unicellular forms in which there is an increasing complexity, such as *Paramoccium*, *Foraminifera*, *Diatorus*, and *Mucor*.

Next come organisms, in which complexity is attained by cell multiplication, though with little differentiation, fungi, and algæ; then solid aggregates in which differentiation is a marked factor, such as *Hydra* and *Porpita*. From these he proceeds to polygordius, mosses, and ferns. About fifteen pages are given to the higher types, starfish, crayfish, mussel, and dogfish, and to the higher plants, and special discussions on cells and nuclei. Biogenesis, homogenesis, origin of species, etc., are discussed in special chapters. In general, little criticism is suggested by the facts stated. For the teacher it may be said to be wholly unfit for elementary work, properly so-called. The author revels in a truly Lankesterian pollysyllabic vocabulary, which the 13-page double-column index by no means fully explains. A very disproportionate amount of space is given to a few low types, and the pupil cannot obtain any general idea of the animal kingdom from the book without an amount of knowledge, insight, and study not to be expected of beginners. We should think the book well adapted to deter any student who was obliged to use it from taking any further interest in the study of biology, though an accomplished teacher might find it suggestive of what to avoid in his work.

AMONG THE PUBLISHERS.

THE Duke of Argyll will publish in the fall a book called "The Unseen Foundations of Society," which is described as an examination of the fallacies and failures of economic science due to neglected elements.

— The New York History Co., 132 Nassau St., N. Y., have just ready the second volume of the "Memorial History of the City of New York."

— Harry de Windt has written a book entitled "Siberia as It Is," which appears to be a defence of the Russian system of prison management, and is intended to be a reply to Mr. George Kennan and other travellers and writers who have attacked that administration as a system of "cruelties and atrocities which is a disgrace to a civilized country and to the nineteenth century."

— It is thought that it may be possible to bring out additional volumes of Freeman's "History of Sicily," so large is the mass of MSS. left by the historian. The MS. referring to the Norman conquest is practically complete, and would form a volume by itself. Besides all this, Freeman left more or less complete materials for a history of Rome down to the time of Mithridates; considerable fragments of a history of Greece; a work on King Pippin; a fragment of Henry I.; and some other manuscripts.

— W. B. Saunders, 913 Walnut Street, Philadelphia, have just ready "A New Pronouncing Dictionary of Medicine," by Dr. John M. Keating and Henry Hamilton. The work is a voluminous handbook of medical, surgical, and scientific terminology, containing concise explanations of the various terms used in medicine and the allied sciences, with phonetic pronunciation, etymology, etc.

— The F. A. Davis Company, Philadelphia, have just ready a new edition (the tenth) of the "Book on the Physician Himself, and things that concern his reputation and success," by Dr. D. W. Cathell, of Baltimore. The Davis Company will publish early in September "The New Pocket Medical Dictionary," compiled by Dr. David Braden Kyle from the latest authorities, and containing words recently introduced into medicine; also, addenda of abbreviations, affixes, list of diseases known by proper names, list of poisons and their antidotes, etc.

— The Clarenden Press has just issued a collection of the principal speeches delivered during the French Revolution, edited by Mr. H. Morse Stephens, the English historian of that period. The orators chosen are eleven in number, including Mirabeau, Barère, Danton, Robespierre, and St. Just. Prefixed to each is a life and explanatory comment; while a general introduction deals with

French oratory in general and the oratory of the Revolution. Many of the speeches have not before been reprinted, even in France; and special attention has been paid to securing an accurate text, and to the spelling of the proper names.

— W. H. Allen & Co , London, are going to bring out with all speed Dr. Steingass's "Persian-English Dictionary," which has been six years in preparation, and which has been subsidized by the secretary of state for India. Another book is to appear in October, viz., two volumes on the history of the land revenue of Bombay, by Mr. A. Rogers, a retired civilian, who has searched the records at the India Office and traced the various changes introduced since the days when the Marathas handed over the task of gathering the revenue to the highest bidder. The work will be illustrated by a map of each collectorate, reduced from maps supplied by the Government of Bombay. Mr. Demetrius Boulger is going to write for Messrs. Allen a popular history of China.

— The August number of *The Mother's Nursery Guide* contains a number of articles that will be valuable to mothers of young children during the present season. Dr. H. D. Chapin, in an article on "Catarrh of the Stomach," gives explicit directions as to the diet necessary in this common ailment; the medical editor describes "Some Improvements in the Preparation of Infants' Foods," and Dr. S. M. Ward has a paper on "Intestinal Worms," which in some respects runs counter to the prevailing medical opinion on that subject. He says: "I am constrained to believe that young physicians pooh-pooh the suggestions of mother and grandmother too often, when asked if worms may not be the cause of certain symptoms which the child presents." The article will be found very suggestive and practical. The "Mothers' Parliament" contains letters on "Summer Recreation with Baby," "Study of Child Nature," "Choosing a Cow," etc.

— Archibald Constable & Co. have in the press and will publish shortly an authorized translation of "Antagonismus der englischen und russischen Interessen in Asien," with a map embodying the latest information.

— In the *Overland Monthly* for August, in an interesting article, entitled "The Economic Introduction of the Kangaroo in America," Robert C. Auld suggests, to take the place of the defunct buffalo, the introduction of the kangaroo from Australia, it being valuable as providing "flesh, fur, and footwear." He finds that the kangaroo "(1) Is easily domesticated; (2) breeds readily in captivity; (3) is easily maintained; (4) has excellent and abundant flesh of a very edible kind; (5) is valuable as a fur-producer; (6) makes excellent sport when at large; (7) can be bred and reared on an extensive, inexpensive scale, by simply fencing in a tract of country not suitable for other stock; (8) becomes easily and thoroughly acclimated, and is quite hardy; (9) and can be procured very easily and cheaply.'

Publications Received at Editor's Office.

BEAL, W. J., AND WHEELER, C. F. Michigan Flora. Agricultural College, Mich. 8°. Paper. 180 p.

CONNECTICUT. Fourteenth Annual Report of the State Board of Health. New Haven The State. 8°. 240 p.

FOWLER, N. C., JR., AND OTHERS. Home Warming and Ventilation. Geneva, N. Y., Herendeen Mfg. Co. 12°. Paper. 64 p.

GANYMEDE. Problems in Physics and their Application to Dynamic Meteorology. Published by the Author. 8°. Paper. 48 p.

MACOUN, JOHN. Catalogue of Canadian Plants. Part VI. Musci, Montreal, Government. 8°. Paper. 295 p.

WILLISTON, S. W., AND OTHERS. Report on the Examination of Certain Connecticut Water Supplies. 8°. Paper. 439 p.

Reading Matter Notices.

Ripans Tabules cure hives.

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To exchange; Experiment Station bulletins and reports for bulletins and reports not in my file. I will send list of what I have for exchange. P. H. ROLFS, Lake City, Florida.

Finished specimens of all colors of Vermont marble for fine fossils or crystals. Will be given only for valuable specimens because of the cost of polishing. GEO. W. PERRY, State Geologist, Rutland, Vt.

For exchange.—Three copies of "American State Papers Bearing on Sunday Legislation," 1891, $2.50, new and unused, for "The Sabbath," by Harmon Kingsbury, 1840; "The Sabbath," by A. A. Phelps, 1842; "History of the Institution of the Sabbath Day, Its Uses and Abuses," by W. L. Fisher, 1859; "Humorous Phases of the Law," by Irving Browne; or other works amounting to value of books exchanged, on the question of governmental [illegible] religion, personal liberty, [illegible] "American State Papers," and buy other books on the subject. WILLIAM ADDISON BLAKELY, Chicago, Ill.

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Wanted, in exchange for the following works, any standard works on Surgery and on Diseases of Children: Wilson's "American Ornithology," 3 vols.; Coues' "Birds of the Northwest" and "Birds of the Colorado Valley," 2 vols.; Minot's "Land and Game Birds of New England;" Samuels' "Our Northern and Eastern Birds;" all the Reports on the Birds of the Pacific R. R. Survey, bound in 2 vols., morocco; and a complete set of the Reports of the Arkansas Geological Survey. Please give editions and dates in corresponding. R. ELLSWORTH CALL, High School, Des Moines, Iowa.

To exchange Wright's "Ice Age in North America" and Le Conte's "Elements of Geology" (Copyright 1882) for "Darwinism," by A. R. Wallace, "Origin of Species," by Darwin, "Descent of Man," by Darwin, "Man's Place in Nature," Huxley, "Mental Evolution in Animals," by Romanes, "Pre-Adamites," by Winchell. No books wanted except latest editions, and books in good condition. C. S. Brown, Jr., Vanderbilt University, Nashville, Tenn.

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Any person seeking a position for which he is qualified by his scientific attainments, or any person seeking some one to fill a position of this character, be it that of a teacher of science, chemist, draughtsman, or what not, may have the 'Want' inserted under this head FREE OF COST, *if he satisfies the publisher of the suitable character of his application. Any person seeking information on any scientific question, the address of any scientific man, or who can in any way use this column for a purpose consonant with the nature of the paper, is cordially invited to do so.*

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TRANSLATOR wanted to read German architectural works at sight (no writing). One familiar with technical terms desired. Address "A.," Box 149, New York Post Office.

— D. Van Nostrand Company will publish in the fall in their Science Series "A French Method of Obtaining Slide-Valve Diagrams," by Lloyd Banston, Ass't Naval Constructor, U. S. Navy, and "A Graphical Method for Swing Bridges," by B. F. La Rue.

— Professors W. J. Beal and C. F. Wheeler have prepared for the thirteenth annual report of the State Board of Agriculture of Michigan a catalogue of plants of the State. It contains 180 pages, and is much more than a mere list. In the 114 orders represented, these including the phanerogams and vascular cryptogams, there are 554 genera and 1746 species and varieties. A map showing the provisional districts into which the State is divided is prefixed to the catalogue. The distribution of each plant is mentioned, and remarks are made upon many species. It is only possible to refer to some of the numerous topics touched upon in the introductory remarks. Among them we find a general description of the topography of the State, with lists of the plants characteristic of the ten districts, lists of the plants occurring in the "Jack-pine plains," the prairies, and in the eastern and western sides of the State in the latitude of 44° 40′. There are also valuable hints in regard to the trees best adapted for planting about the home and along the roadside; planting a wild garden; trees and shrubs noted for the color of their foliage in autumn; native climbing plants; plants indicating a fertile soil; trees valuable for timber; native and introduced weeds; rare or local plants; medicinal plants, etc. Not the least interesting topic is that relating to wild fruits and nuts, the remarks of Dr. Asa Gray made in 1873 being quoted. He speculated upon what the results would have been if our civilization had had its origin in North America instead of the Old World. Apples would have developed from the wild crab; plums from several wild species; the persimmon, the paw paw, the ground nut, hickory nut, and walnut would hold the places now filled by others; and perhaps 2,000 or 3,000 years hence some of these will have taken a front rank among the edible fruits of the then existing races of men.

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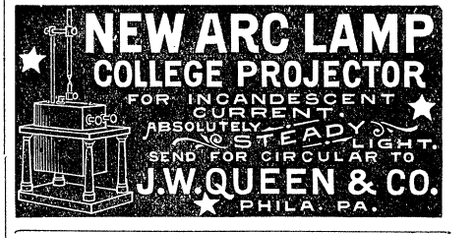

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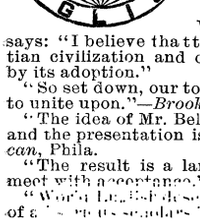

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First inserted June 19. No response to date.

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TO THE READERS OF SCIENCE.

PUBLISHER'S ANNOUNCEMENT.

Titles of Some Articles Published in *Science* since Jan. 1, 1892.

Aboriginal North American Tea.
Actinism.
Agriculture, Experimental, Status of.
Amenhotep, King, the tomb of.
Anatomy, The Teaching of, to Advanced Medical Students.
Anthropology, Current Notes on.
Architectural Exhibition in Brooklyn.
Arsenical Poisoning from Domestic Fabrics.
Artesian Wells in Iowa.
Astronomical Notes.
Bacteria, Some Uses of.
Botanical Laboratory, A.
Brain, A Few Characteristics of the Avian.
Bythoscopidæ and Cereopidæ.
Canada, Royal Society of.
Celts, The Question of the.
Chalicotherium, The Ancestry of.
Chemical Laboratory of the Case School of Applied Science.
Children, Growth of.
Collection of Objects Used in Worship.
Cornell, The Change at.
Deaf, Higher Education of the.
Diphtheria, Tox-Albumin.
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Iowa Academy of Sciences.
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Wines, The Sophisticated French.
Zoology in the Public Schools of Washington, D. C.

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